ELEVATORS

The
Travelers Insurance Company
HARTFORD, CONNECTICUT

NOTES ON THE EQUIPMENT AND OPERATION OF ELEVATORS

The

Travelers Insurance Company

HARTFORD, CONNECTICUT

7270. 6-13-'13.

PREFACE

There are few who realize what a large field for study there is in elevator engineering. The general feeling, without doubt, is that in making an inspection there is nothing to do but to look for flaws and evidences of weakness, in the cables and other parts that are subject to stress.

Although the following pages merely touch upon the salient points they nevertheless show how erroneous such a view is, and how broad, varied, interesting, and extremely important the subject becomes, when it is rightly pursued. The Engineering and Inspection Division of The Travelers Insurance Company has followed the development of elevator engineering for many years, and has, in fact, been an active factor, itself, in the progress toward better and safer mechanisms and methods.

It is the purpose of this pamphlet to briefly outline the principal requirements which make for safety in the daily use of the elevator, to point out certain features that have been shown to be sources of trouble by the

experience of many years, and to illustrate what is being done in the way of introducing improved methods and appliances. We trust that it may be serviceable to those who have to deal with elevators in any way, and that it may stimulate interest in the work of accident prevention as related to elevator transportation.

We acknowledge, with sincere thanks, the courtesy extended to us by the owners of the various installations that are illustrated in these pages, in permitting us to make the photographs, and to use them for the benefit of others.

THE TRAVELERS INSURANCE COMPANY
Hartford, Connecticut.

Notes on the Equipment and Operation of Elevators

INTRODUCTORY: The present-day problem of the vertical transportation of passengers and freight, which has arisen as a consequence of the congestion of industrial, mercantile, and social activities about certain centers or foci, is not only very important, but also, in many ways, very difficult. The growing tendency toward the construction of high buildings for factories, as well as for hotels and offices, makes the adoption of some form of mechanical lifting apparatus a necessity,—whereas in the past such devices have been luxuries, for the most part. The elevator has proved itself to be an effective appliance, and its importance is so great that it may now be said to be the determining factor in modern building construction. That is, it is the practicability of proper elevator service that limits the size of the building,—and particularly its height. As the rapid skyward growth continues, the importance of the elevator in comparison with other

features of the building equipment will become even more marked.

Many thousands of persons use elevators every day, and they have a right to assume that all necessary provisions have been made for ensuring safety Under proper conditions an elevator is safe and reliable for the transfer of freight or passengers, and it does its work with despatch and smoothness. Serious accidents are frequent, however. Some of them result from the breakage of defective parts, some from poor or inadequate equipment, some from negligence in the supervision and operation, and some from carelessness on the part of those who ride or who handle the materials that are transported. The greater part of these accidents may be avoided by the exercise of a reasonable amount of care by the builders, the owners, and the public. At the present time those who own and operate elevators, and those who use them, show a noticeable lack of attention to the things that tend to ensure safety. We therefore wish to emphasize the fact that the force of gravity, unlike the individuals who are so often lax and indifferent, is ever alert and vigilant, and that it never fails to bring any unsupported object back to earth promptly and positively.

Once installed, an elevator becomes a fixed feature of the building, and remains in service for a long term of years,—usually until the building itself is removed. If it is deficient in the essentials for satisfactory service,

it will nevertheless be continued in use, as a rule, for a considerable time,—a source of danger, inconvenience, and expense. When a poorly arranged installation has to be considered, much can be accomplished by eliminating its hazardous features and improving the existing appliances; but obviously it is far more satisfactory and economical to provide suitable structural parts when new equipment is being arranged for, and we would strongly urge that owners and architects give careful attention to the subject of security and safety, before installing the elevators. It is only by avoiding the defects that have proved disastrous in the past that the elevator equipment of the future can be ultimately perfected; and in this connection we wish to state that the adoption of high-grade machinery and shaftway construction is advisable from every point of view. It is of course safer, and it will also result in a saving, ultimately, because of the reduced cost of maintenance and repairs.

In the following outline we have indicated the general requirements of elevator equipment and service, so far as they relate to mechanical features.

PASSENGER CARS

ENCLOSURE: Passenger car enclosures should be substantially constructed, preferably of fireproof material, and they should be designed so as to effectively confine the materials or the persons that are being

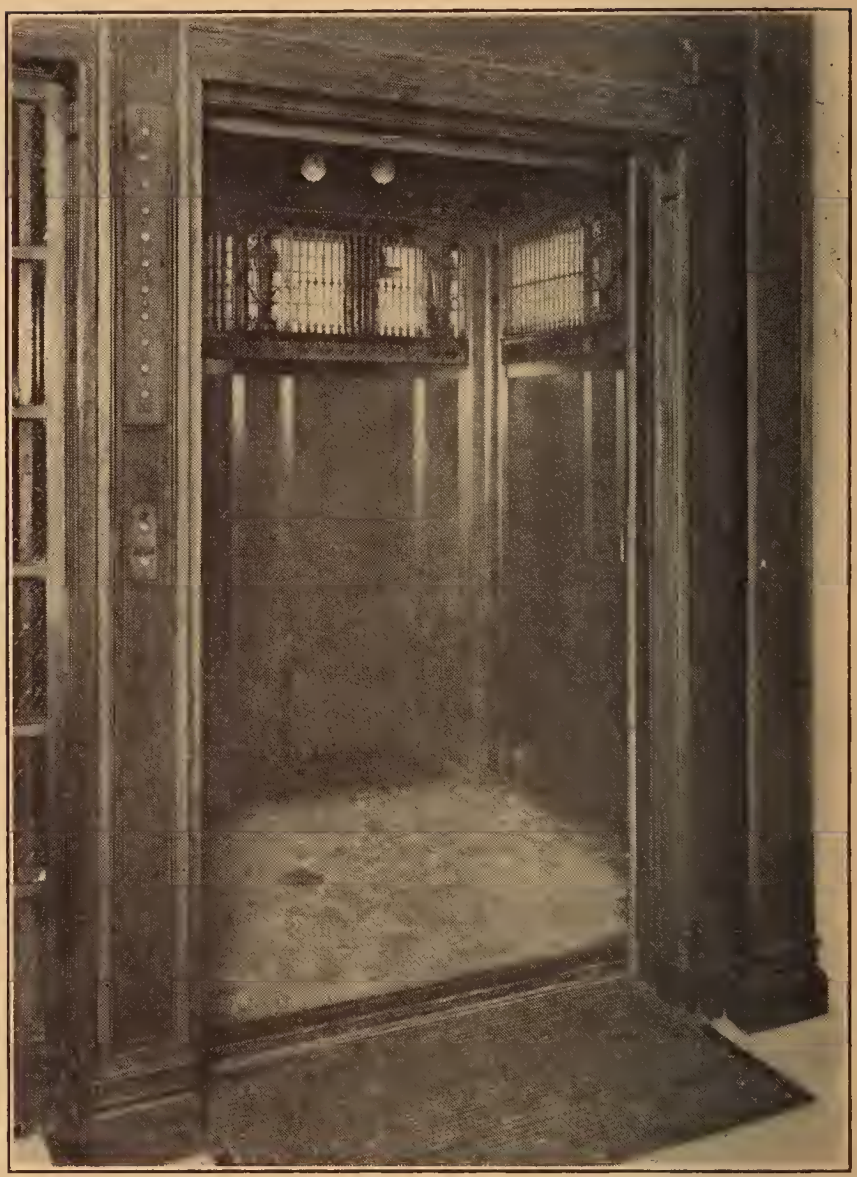

FIG. 1.—THE MOST APPROVED FORM OF CAR ENCLOSURE.

(The solid paneling extends upward from the floor to a height of six feet; suitable provision is made for ventilation; the roof of the car is made of sheet metal, and is flat; cork tiling is used to cover the floor; good artificial illumination is afforded by frosted incandescent bulbs; there is a non-slip surface on the floor of the building at the entrance to the shaftway; and there is an effective indicator panel on the shaftway enclosure, by the side of the door.)

transported. Hard wood may be used for the floors and the panel work, but mirrors or similar ornaments of glass should never be permitted. The most desirable construction for the car enclosure has solid panels to a height of six feet or more, with open grille or screen work above, to provide for ventilation. Fig. 1 illustrates a design of this type which is rigid without being unnecessarily heavy, and which meets all reasonable requirements for decorative finish as well as for mechanical construction.

It is highly desirable to have a collapsible gate on the car, in addition to the doors at landings,—particularly where cars are crowded and are run at high speed. Collapsible gates of this kind are required by ordinance in some cities.

The roof of the car should be made so that it will protect the passengers against falling material, and so that it will also provide a safe footing for the engineer when he is standing upon it to make adjustments or repairs, to examine the cables, or to do the necessary oiling. A section of the roof should be hinged so that it can be lifted upward, to form an emergency exit; or a door can be provided for this purpose in the side of the car, when two or more cars run side by side in the same shaftway.

On account of the open spaces common to grille-work cars, and to other forms of metal enclosures that have been extensively used in the past and which are

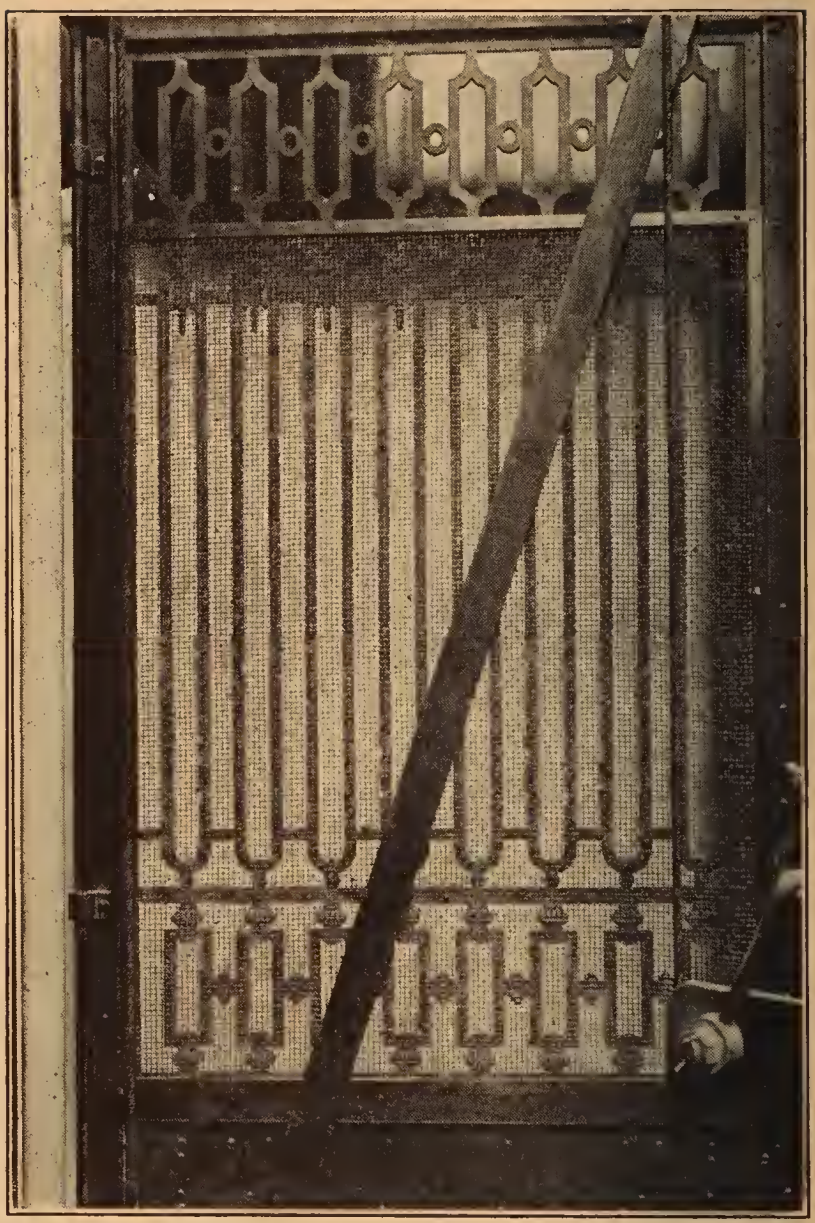

FIG. 2.—SHOWING THE APPLICATION OF WIRE SCREENS TO CARS OR SHAFTWAY ENCLOSURES.

(The screens are attached to metal frames of suitable dimensions, at the shop, and they are afterward fastened in place by screws. The screens are durable when properly made up and secured in this manner, and they do not detract from the appearance of the iron work.)

still in favor with some builders, it is frequently important to apply wire screens in order to confine the hands and arms of passengers within safe limits, and prevent contact with counterweights or shaftway girders. Fig. 2 shows how this can be best accomplished. The screens are here set in metal frames, instead of being attached directly, and the frames are then securely fastened to the car.

A separate compartment, for the transportation of freight, should never be provided, either above or below the passenger cage.

The car should have but one entrance, more than that introducing unnecessary hazard.

FLOOR: The platform should be floored with a material that will prevent slipping, and that will be sufficiently durable to resist wear for a reasonable period. The flooring should be properly laid, so as to give an even and continuous surface, and offer no chance for passengers to trip or stumble. Cork and rubber tiling, or heavy rubber mats made in one piece, are the coverings most commonly used for the car platforms. A wooden floor is satisfactory if it is kept in good condition, but it is apt to wear rapidly at the entrance. No smooth metal plates should be permitted at the entrance, nor elsewhere on the floor; and all floor tracks, for guiding the gates or for other purposes, should be set flush with the floor.

CONTROL: The location and arrangement of the controlling device in relation to the shaftway doors have much to do with the safety and convenience of operation. It should never be necessary for the operator to release his grip on the controller, in order to manipulate the door lock. When a lever is employed, the movements of the operator will be simplified if the lever is located on the front side of the car, and arranged to swing parallel with the doors. The lever should be protected by a shield, to prevent the accidental starting of the car.

LIGHT: Suitable artificial light is necessary on practically all passenger cars, and the incandescent electric lamp is really the only source of light that is satisfactory for this purpose. See Fig. 1.

SAFETY DEVICES: Multitudes of devices have been designed to prevent elevator cars from falling in case the supporting cables fail, and many of these have been tried out in actual service. Some few of them still remain in use, and are more or less effective. There is but one type of safety device, however, upon which reliance should be placed, in passenger service;—namely, the clamp type, operated by a speed governor, and so designed as to grip the rails with a gradually increasing pressure. All passenger cars that are suspended by cables should be equipped with safety devices of this kind, whether they are of high or low

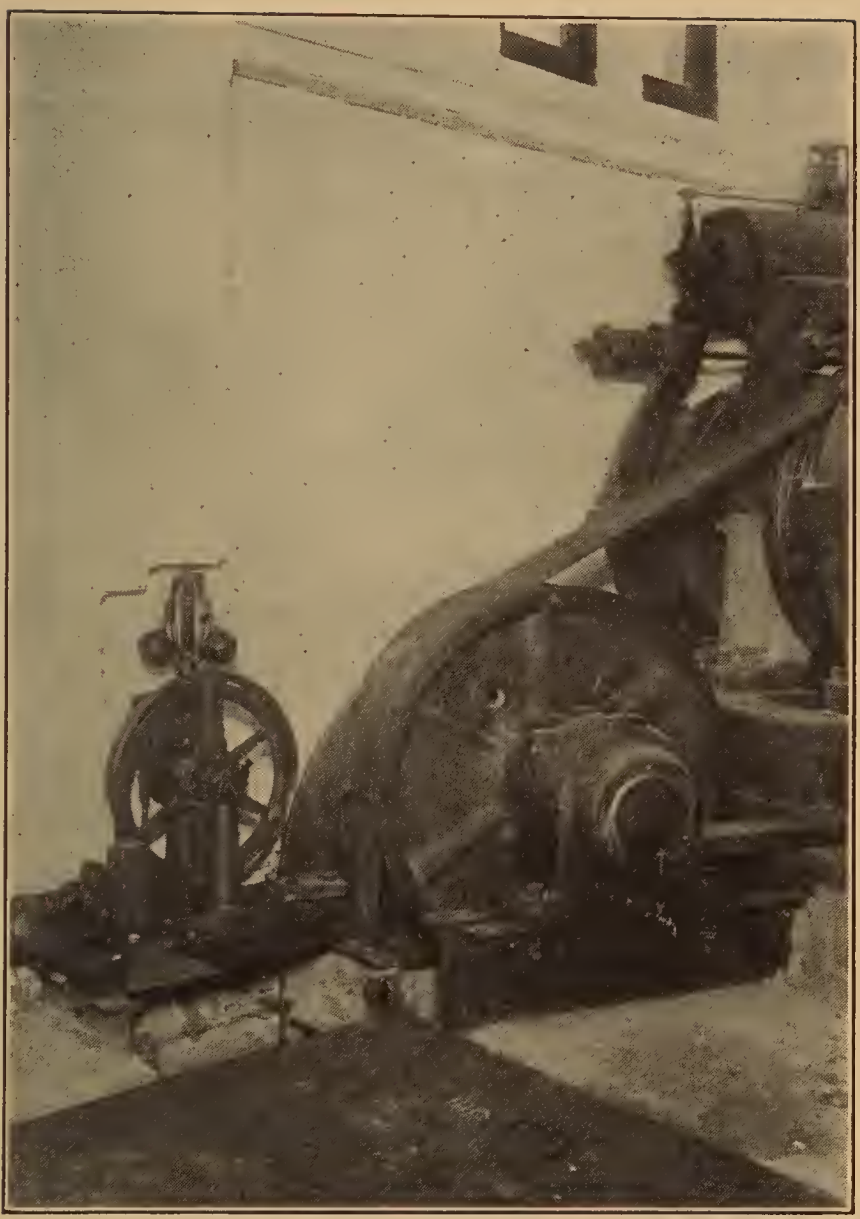

FIG. 3.—A SPEED GOVERNOR SET DIRECTLY OVER THE COUNTERWEIGHT RUNWAY.

(The governor operates a clamp safety device to which it is connected, and which is located on the counterweight frame. This is in addition to the regular governor-controlled car safety, and the speed-limiting device on the driving machine.)

speed. This refers to *car devices only.* There are also a number of *special* safety appliances that are reliable, and these are being installed to a considerable extent in *addition* to the regular car equipment. Some of the elevators that have been recently built are provided with three or even four distinct safety devices, independently operated. Fig. 3, for example, shows a speed governor in use to operate a safety grip on the counterweights, in addition to the regular safeties and the speed governing device upon the driving machine itself.

The safety devices that are used upon elevators should be tested at regular intervals, when it is practicable to make such tests without exposing the operator of the car to serious danger.

EMERGENCY BRAKE: Under certain conditions it is advisable to provide an emergency brake which can be thrown into contact with the rails at the will of the operator. The importance of this feature will depend upon the speed and the height of travel. An emergency brake is shown in Fig. 13.

EMERGENCY SWITCH: In systems that are run by electric motors, each car should be equipped with an emergency switch, to be opened by the operator under certain circumstances,—the machine brake being in this way applied and the power cut off. (See Fig. 13.)

FREIGHT CARS

ENCLOSURE: Cars that are used for transporting freight should be enclosed, on the three sides not used for the entrance, by solid sections of wood or sheet metal, securely braced and anchored, and not less than six feet high. Many freight cars, of course, have more than one entrance, and in such cases it is necessary to leave each of the entrance sides open, or to provide them with folding gates. In laying out building plans, however, it is usually possible to limit the number of entrances to one, and this is advisable, because it reduces the exposure to a practical minimum. The proper housing of a freight car not only increases the safety of operation but also facilitates the handling of material. Fig. 4 shows a suitable enclosure as applied to a factory elevator.

It is desirable, in many cases, to roof the car over with a wire screen. When this is done, the front half of the frame should be hinged at the crosshead so that it will be free to swing upward if it is fouled by any object at the landings, as the car descends.

Sidewalk elevators should be built with a framework above the platform, strong enough to prevent injury to a person standing on the platform, in case the hatch doors are locked when the car is run up; or else they should be provided with a device that will prevent the operation of the car while the doors are shut.

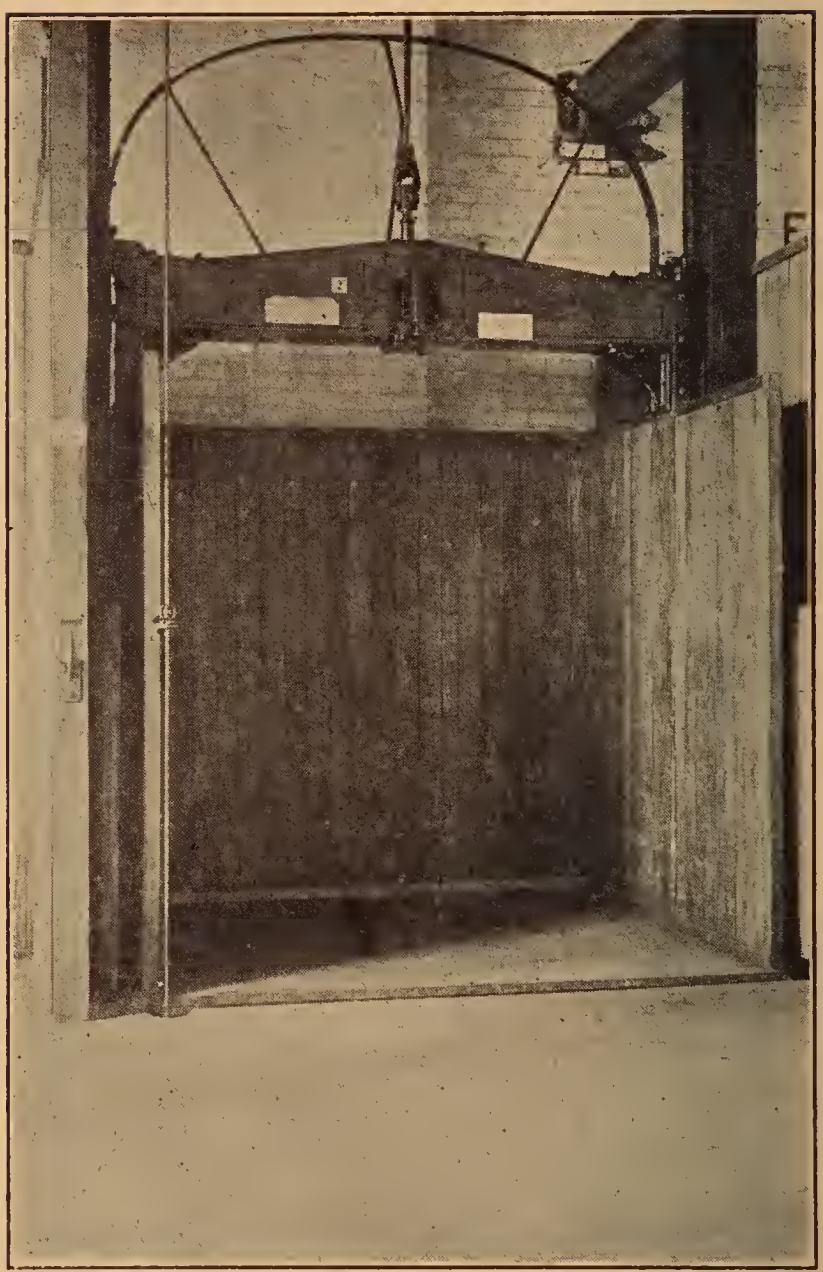

FIG. 4.—A FREIGHT CAR ENCLOSURE OF DESIRABLE TYPE.

(Three sides are substantially boxed in, to a height of six feet. In many cases it is also desirable to roof the car over with a heavy wire-mesh screen, hinged at the crosshead.)

Many persons have been crushed between the car platform and the overhead doors, in consequence of the neglect of these precautions. The sidewalk opening may have hinged doors, or it may have a cover of the "pick-up" type. The latter form has some advantages. Compare Figs. 5, 6, 7, and 8. The cover or doors, when closed, should be flush with the sidewalk.

CONTROL: The controlling device, which is usually a hand cable, should be equipped with a lock that will prevent the car from being moved while loading or unloading is in progress. This may also be secured by a padlock or its equivalent, to prevent the operation of the elevator by unauthorized persons. A convenient form of controller lock now on the market is fitted with a cylinder lock and key in addition to the usual finger latch.

LIGHT: Artificial light should be provided in most cases, and particularly when the car runs in a closed shaftway; because natural light is not adequate during the entire working day, in all parts of the year. As in the case of passenger cars, electric lamps are best for this purpose.

SAFETY DEVICES: A quick-operating device, which seizes the rails and brings the car to an abrupt stop, can be used to advantage upon freight cars, because they are run at a speed much lower than that which is common on passenger cars. Several forms of

FIG. 5.—ILLUSTRATING THE USE OF A COLLAPSIBLE GATE AT THE SIDEWALK OPENING, INSTEAD OF A BAR OR A CHAIN GUARD.

(Bars or chains are not suitable for protecting shaftways of this kind. Compare Fig. 8.)

FIG. 6.—SHOWING HEAVY CHANNEL ARCHES ABOVE THE PLATFORM OF A SIDEWALK ELEVATOR.

(An arrangement like this, or equivalent to it, is highly important when doors of this type or a similar type are used, unless an automatic device is employed, to prevent the operation of the car while the doors are [redacted] closed.)

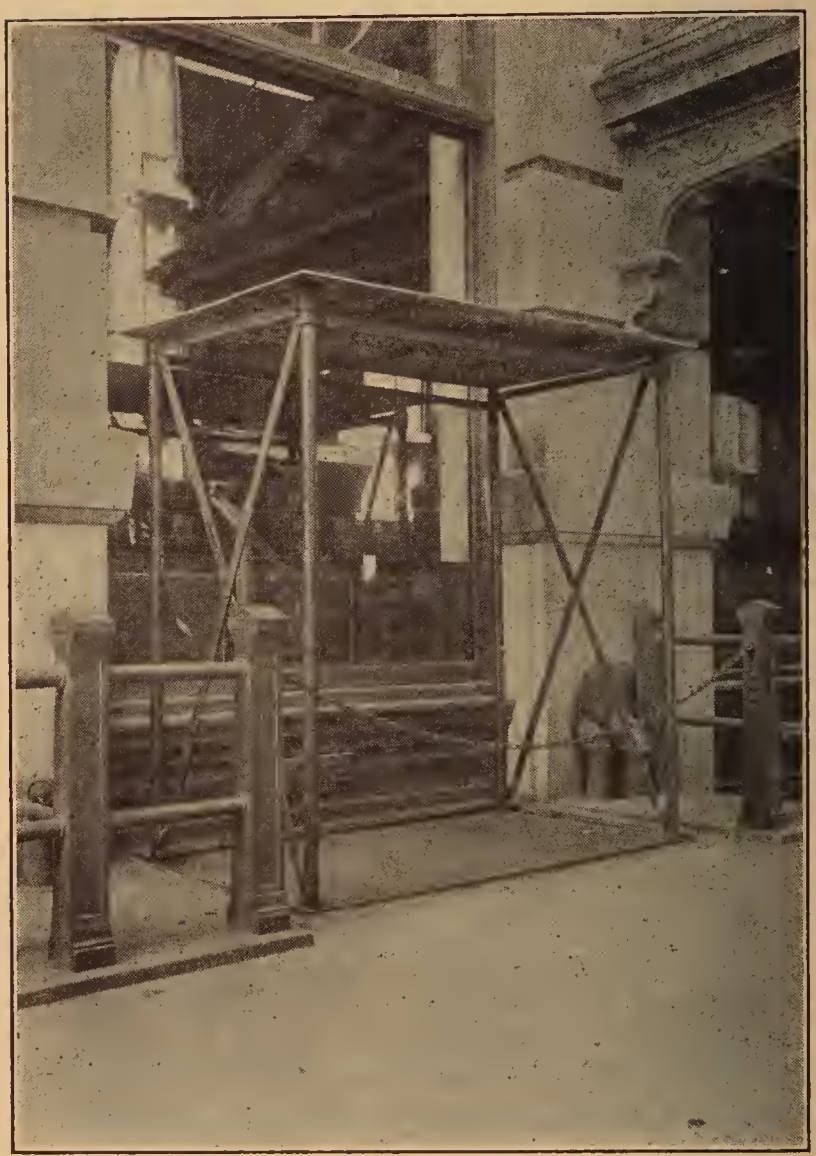

FIG. 7.—THE MOST APPROVED TYPE OF SIDEWALK ELEVATOR, AS SEEN WITH THE PLATFORM AT THE STREET LEVEL.

(The hatch cover is picked up as the car ascends, and when the car goes down the cover is lowered into place again, so as to automatically close the opening and make a gate unnecessary. By the use of telescoping tubes at the corners, the cover is locked in place when the car is at the bottom of the shaftway, thus doing away with ordinary locks, and leaving the cover always free to lift when the car is raised. Compare Fig. 8.)

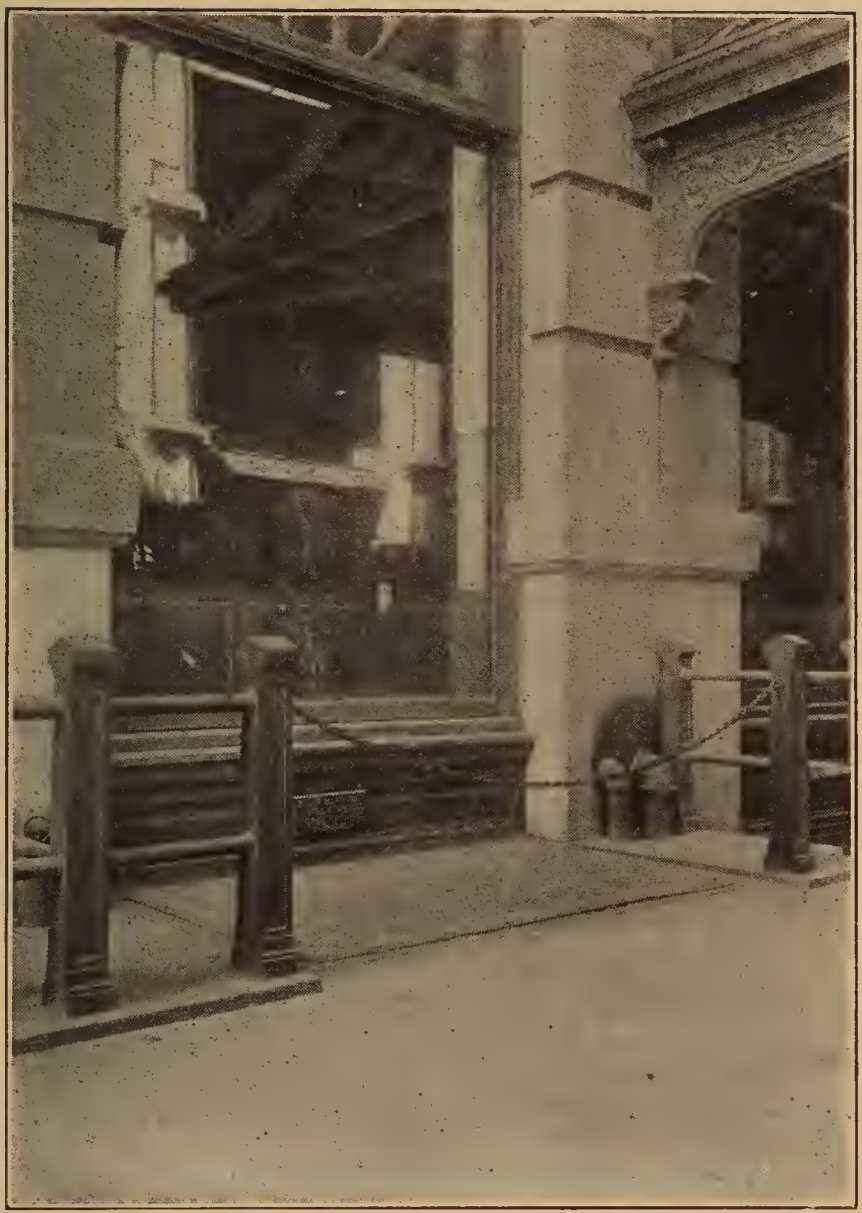

FIG. 8.—THE INSTALLATION SHOWN IN FIG. 7, AS SEEN WHEN THE CAR IS BELOW AND THE HATCH COVER IS IN PLACE.

(The chain that hangs across the front of the opening, from post to post, is not intended as a guard for the shaftway. It serves merely to prevent persons from standing on the cover.)

grip are available, the design depending largely upon the material composing the guide rails. For wooden rails, a common form consists of double sets of cams, faced with teeth and set to make contact with opposite sides of the guide rails. For steel rails, one of the best forms employs corrugated rollers of hardened steel, which are lifted up to engage the face of the guide, and to jam between it and the shoes, in a wedge-shaped recess. Clamp safeties may also be applied with advantage, particularly when the lift is high; but they are not considered essential for the average freight car. At present the gripping devices on freight cars are usually operated by a breaking-cable mechanism,—that is, by one that is released by the breaking of the hoisting cables, and actuated by a spring or weight, or both. This method of release is useless, however, when the car attains a dangerous speed through the failure of some parts of the driving machine. It has also proved unreliable when cable breaks have occurred at the driving machine end, the weight and drag of long lengths of cable extending from the top of the shaftway to the machine room in the basement being sufficient, in many cases, to prevent the operation of the safety. For these reasons we believe that a speed governor should be provided in all cases, to trip the safety device.

It is quite as important to provide safeties on elevators that are operated by hand, as it is to provide them on power-driven installations. The hand-driven ones

are often subjected to severe strains, and when heavily loaded they may attain a dangerous speed. As they are ordinarily designed, the stripping of a few spur-gear teeth, or the spreading of shaft bearings, will allow the car to fall freely, unless it is caught by safety grips.

Sidewalk elevators, except those of the plunger type, should also be equipped with safety devices when the total travel exceeds twelve feet. They are not commonly provided with emergency grips, but there is no good reason why they should not be so equipped, particularly when they run to sub-basements. On account of the moisture present in most basements, and the exposure of these installations to the weather when the doors are open, the cables and other parts are apt to deteriorate rapidly through corrosion. Under these special conditions the hydraulic plunger type of lift is particularly desirable, since it disposes of the safety device question, and, furthermore, its durability is not materially affected by moisture nor by corrosive fumes.

PASSENGER ELEVATOR SHAFTWAYS

ENCLOSURE: The shaftway must provide a safe place for the travel of the car,—excluding all outside material from its path, and protecting persons who may be at landings, or on stairways, from contact with the car or with the weights or any other moving parts. The shaft enclosure should be continuous from the bottom of the shaftway to the top, and it should be of fireproof

FIG. 9.—APPROVED FORM OF SHAFTWAY DOORS.

(This form of construction, or its equivalent, should be adopted on all new installations. There is no recess under the floor saddles, and the sills do not project. When these doors are closed, a continuous, smooth, unbroken surface extends from the top of the shaftway to the bottom, in front of the car opening. These shaftway doors are wider than the opening in the car.)

construction. Wired glass may be used to advantage in connection with metal framework, the panes being limited in size to an area of five square feet each. The part of the shaftway opposite the car opening should be built without projections or recesses of any kind, and it should form with the shaftway gate an unbroken surface. Flush construction of this kind is shown in Fig. 9, the width of the shaftway doors exceeding that of the car opening. Grille work or other open work cannot be recommended for enclosures,—particularly for the front side. The shaftway must be kept clear of all piping, wiring, and shafting, not connected with the elevator. The hoisting machine should never be located in the pit.

DOORS: These should be of the sliding type, and preferably of metal. They should be carefully hung and substantially constructed with solid panels, but they should not be unnecessarily heavy. It is important that the doors be fitted on the inside with reliable locks that are accessible only to the operator, under ordinary conditions,—keys being provided for unlocking them from the outside in case of emergency. Too much emphasis cannot be laid upon the importance of providing the best possible door and lock equipment. The possibilities that are involved in the opening of shaftway doors when the cars are in other parts of the shaftways, or in the movement of the cars before the doors are

closed, are well illustrated by the large number of accidents that result from these sources. The danger of falling down a shaftway is commonly recognized in a general way, but the danger of personal mutilation is seldom appreciated. The conditions that prevail, when a car moves past an open shaftway entrance in either direction, are similar to those that would exist in a huge pair of shears; and a person caught between the stationary parts and the moving ones is almost invariably killed by the shearing and crushing action. The accidents that occur in this way are too ghastly to dwell upon, but the frequency of their occurrence is a matter which deserves serious attention. It should lead to the adoption of more effective devices for their prevention than are now in common use.

AUTOMATIC LOCKS: To prevent the car from being moved away from a landing before the shaftway door is closed and locked, it is desirable that an automatic locking system be provided which will prevent the controller from being moved while the door is open; and the same device should also prevent the shaftway door from being opened until the car is at the proper level, with the controller lever centered. A device of this kind, to be reliable, must be simple in design, and it must be mechanically strong, and not subject to disarrangement nor to rapid wear. No parts of the mechanism should be exposed in the

shaftway in front of the car opening, not only because this space should always be free from projections that might catch clothing, but also because it is important to make it impracticable, or at least inconvenient, for the operator to trip the lock by his hand or foot, or to render it inoperative in any way. The mechanism that is provided for each door should preferably be independent of that at every other door, and it should be operated by the regular movement of the door as it is opened or closed by the operator,—the door being always under his control. Many difficulties have been encountered in applying automatic locks, and many failures have been reported; but there are several designs which have now passed the experimental stage, and which may be depended upon for satisfactory service. We believe that the careful selection and application of automatic door and controller locks will do much toward reducing a very serious hazard. The temptation or inclination to start cars before the shaftway doors are closed appears to be too strong for human nature to resist, and any device which will serve to check this universal practice merits serious consideration from all owners and managers.

LANDINGS: The approaches to the shaftway doors should receive particular attention. The floors at the landings should be made of material that will prevent slipping as passengers alight from the cars.

Accidents from slipping have become more frequent since fireproof construction has come into general use, and in some cases it has been found necessary to cover smooth tile and mosaic floors with mats of rubber or fiber. Mats, however, must be kept in good condition, so that persons entering or leaving the car will not trip over them; and in any event they must be renewed from time to time. These difficulties may be overcome by the use of suitable material in laying the floors. For this purpose vitrified tile containing abrasive material, and non-slip treads laid flush with the floor surface, have been used with satisfactory results. (Fig. 10 shows the latter form as used in a modern installation.) Rubber tiling may also be used, under certain conditions, as illustrated in Fig. 11.

LIGHT: Sunlight is the best illuminant for the shaftway during the daytime, and windows should be provided for admitting it, when the arrangement of the building makes this practicable. The shaftway may also be lighted indirectly from the halls and corridors, when wired glass is used in the construction of the enclosure.

COUNTERWEIGHT RUNWAY: Many serious accidents have occurred in connection with counterweights. In some instances sections of the weights have become disconnected and freed from the guides, falling down the shaftway upon the car and its occu-

FIG. 10.—A SHAFTWAY ENCLOSURE OF GOOD DESIGN.

(The special feature to be noted is the use of non-slip floor plates, set flush with the marble tile. The hallway is well lighted, from a source not shown, and the shaftway is lined with white enameled tile. The shaftway doors are also equipped with automatic locks, although these do not show in the engraving.)

pants. In others, persons have been caught between the moving weights and fixed portions of the building, or underneath the weights as they were descending to the bottom. A separate shaftway for the counterweights, as shown in Fig. 12, is obviously the best solution of the problem. When the runway is located in the main shaftway, it should be enclosed by heavy sheet metal for a distance of 10 feet at both top and bottom, and no door nor other opening should be permitted in that portion of the shaftway past which the weights travel.

CLEARANCE: The top and bottom clearance between the car and the fixed portions of the shaftway should be ample to allow for a reasonable amount of over-run beyond the normal limits of travel. The amount of clearance necessary will vary according to the car speed, the type of the elevator, and other matters; but it should not be *less* than four feet at the top and three feet at the bottom. It is hard to lay down a definite rule to be followed in all cases, but a fair estimate of the proper clearance may be obtained by adding to the minimum clearance limits just given, one foot of additional clearance for each hundred feet of car speed in excess of one hundred feet per minute. It is a common fault to provide too little clearance through oversight in laying out building plans.

Between the edge of the car platform and the sills

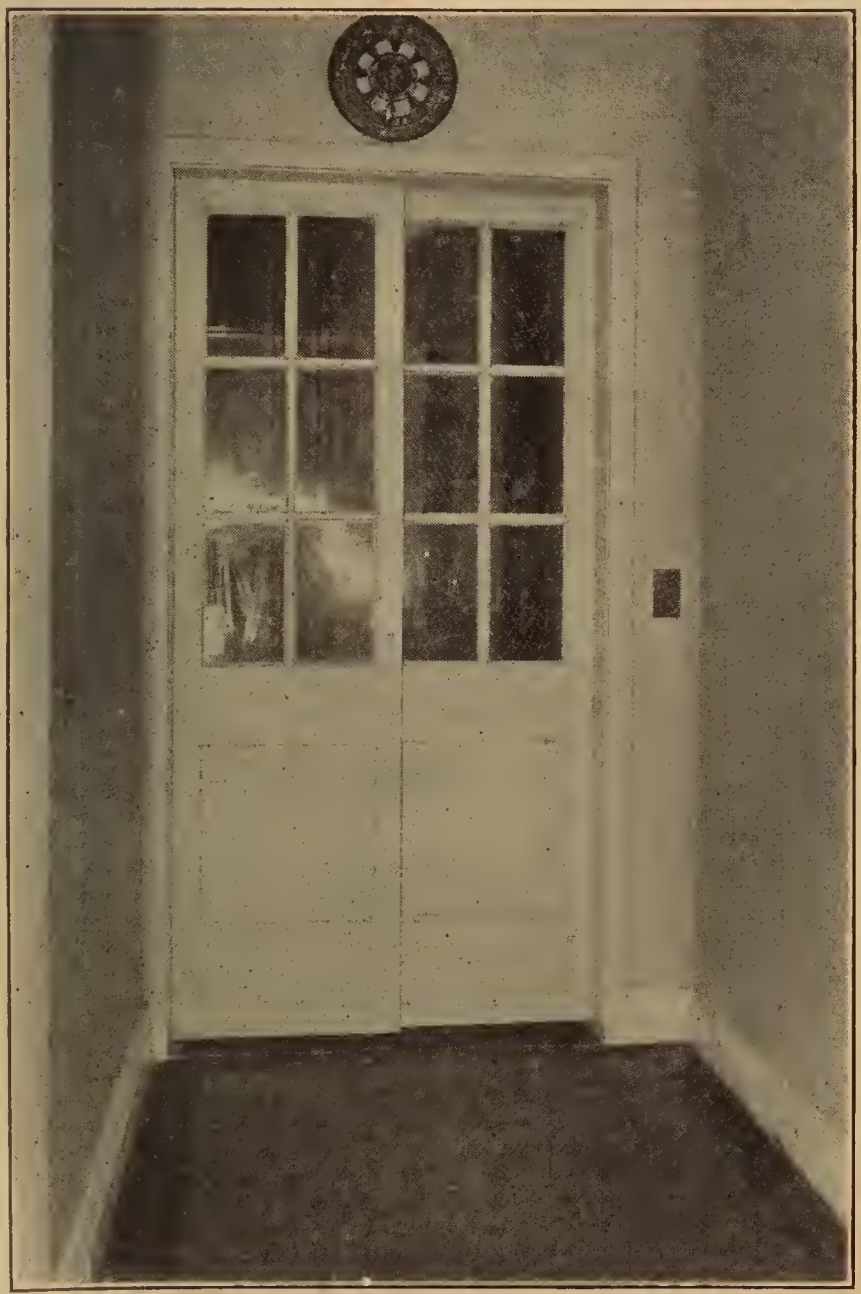

FIG. 11.—ILLUSTRATING THE USE OF RUBBER TILING, TO PROVIDE A SAFE FOOTING IN FRONT OF A SHAFTWAY ENTRANCE.

of the shaftway a clearance of from $\frac{1}{2}$ inch to $1\frac{1}{4}$ inches should be provided.

OVERHEAD SUPPORTS: The transverse beams at the top of the shaftway should be of wrought steel or iron, and they should rest upon substantial supports of steel or masonry. The support for the overhead beams is often made too light, and it seldom errs notably in the opposite direction.

OVERHEAD GRATINGS: A grating or floor should be provided beneath the overhead sheaves, to support men who may be engaged in the care of the working parts, and also to prevent loose material from falling down the shaftway. To guard against displacement, each section of the grating should be securely bolted to the supporting members. As an additional safeguard to prevent tools from slipping between the grate bars and dropping down, a wire mesh screen has been attached to the under side of the grates in some cases. When the hoisting machine is located at the top of the shaftway, a solid floor should be provided for it, in all cases.

An entrance from the outside should always be provided at the top of the shaftway, so that it will be unnecessary to enter the space above the grating from the top of the car, or from underneath in any other way.

FIG. 12.—A SEPARATE COUNTERWEIGHT SHAFTWAY.

(By the use of a separate shaftway for the counterweights, all danger of the fall of weights in the main shaftway is eliminated, and an easy means of examining the weights and their cables is also provided. At each floor there are shaftway doors, similar to the one here shown open, and each of these is fitted with a cylinder lock, so that it can be opened only by the engineer.)

LIMIT SWITCHES: A highly important feature of the modern electrical installation is the use of shaftway limit switches to prevent the car from passing beyond safe limits at the top and bottom. These limit switches should form part of the equipment of all electric elevators.

SIGNALS: Every passenger elevator is equipped with a signal system of some kind. In addition to the regular annunciators by which the operator is signalled to stop at certain floors, indicators should be provided at each landing, showing the approach of every car and the direction in which it is moving. Mechanical devices for this purpose are quite common, and lamp indicators are also extensively used,—a white light meaning that the car is moving upward, and a red light that it is moving downward. The service is greatly facilitated by the use of these car-indicators, and safety of operation is also promoted, because prospective passengers have time to approach the proper door before the car arrives, and the tendency toward confusion or misunderstanding is much reduced. It is a matter of common knowledge that when a passenger boards the wrong car, he usually tries to get off again just as the car is being started.

In high buildings it has been found to be important, and almost necessary, to equip each car with a telephone so that the operators can talk with the starter from any point in the shaftway. There are other cases, also, in which telephones are desirable. (See Fig. 13.)

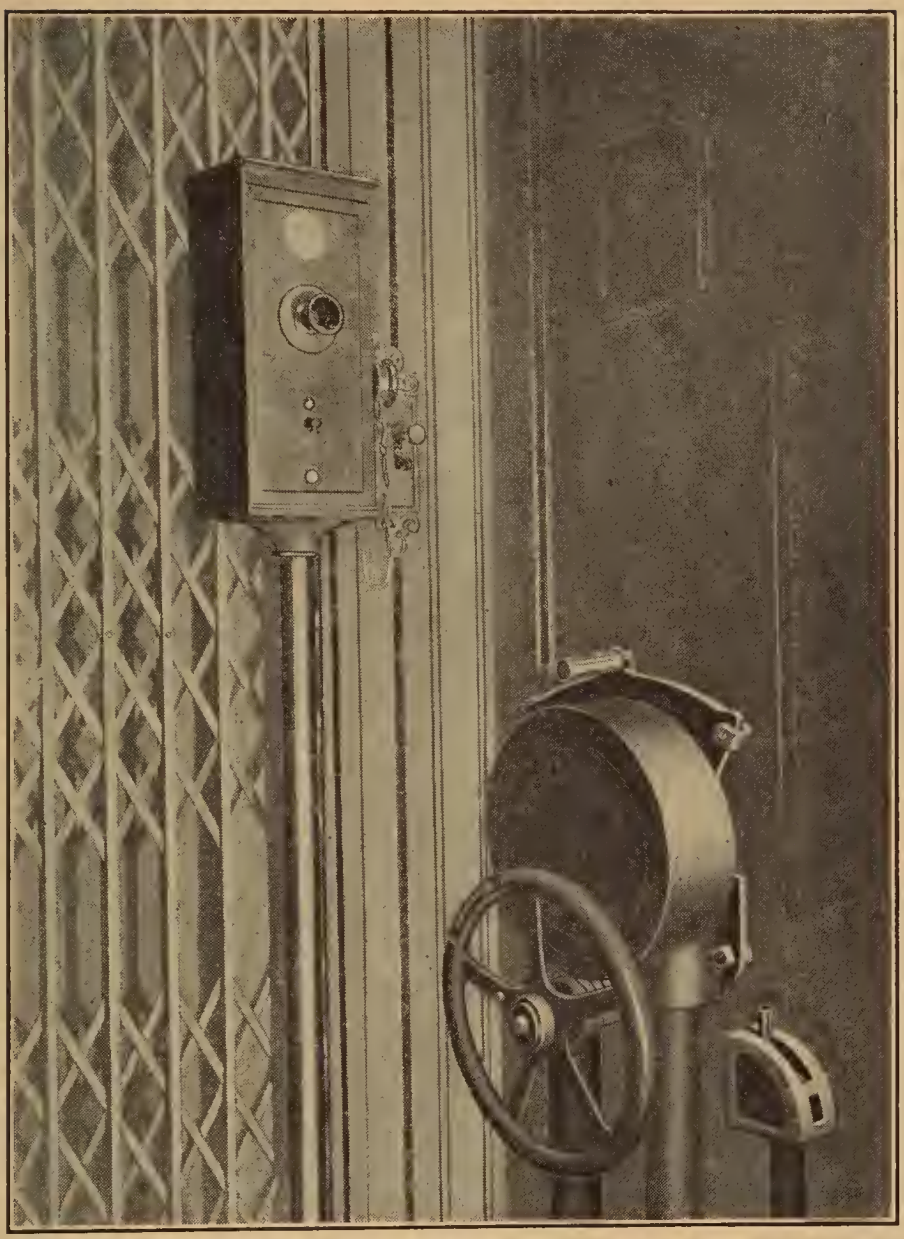

FIG. 13.—INTERIOR OF A MODERN CAR, SHOWING TELEPHONE, EMERGENCY BRAKE, EMERGENCY SWITCH, AND COLLAPSIBLE GATE ATTACHMENTS.

FREIGHT ELEVATOR SHAFTWAYS

ENCLOSURE: Solid shaftway enclosures of fireproof material should be adopted for all freight elevators. The principal points in favor of such enclosures are:—

(1) The guide rails are continuous, with no loose sections.

(2) The guide rails may be more securely anchored. They are thus held in good alignment, and are better able to withstand the continual side thrust, and the stresses resulting from the operation of the safety grips in cases of emergency.

(3) All loose outside material is kept from contact with the traveling car.

(4) No folding hatch doors are necessary.

A great many factory elevators have been installed to run through floor hatchways with no other protection than automatic folding doors, and this mode of operation has been the cause of much trouble. The guides are cut at every floor, and a section is bolted to each of the folding doors. The wear and tear of constant use usually throw these swinging sections out of alignment sooner or later, and frequent adjustment is therefore necessary. If the guides are not kept in alignment, or if foreign material lodges between the doors and the guide posts, the travel of the car is interrupted and damage usually results.

The danger of personal injury is also very serious. It is not unusual to find factory employees passing regularly back and forth over these hatch doors, and using them as common passageways. Even when they are not so used, many a serious accident is recorded, in which an unfortunate person is caught between the opening door and the post or some other fixed object. When doors of this kind are used they should be enclosed (except at the entrance side) by slats or solid partitions 7 feet high, and a semi-automatic lift gate should be installed at the entrance. (See Fig. 14.)

Projections into the shaftway should be carefully avoided. Where floor timbers or other fixed beams exist opposite car openings, the use of bevel plates lessens the danger; but to be of any value these plates should be not less than 12 inches wide, and they should be set flush with the projecting edge, and at an angle with the vertical not exceeding 30°.

Recesses of all kinds, opposite car openings, are likewise to be avoided. Window recesses should be covered by heavy wire-mesh screens, or vertical slats, set flush with the wall.

GATES: Freight shaftways are sometimes entirely enclosed, and equipped with sliding doors having locks on the inside. This form of construction is recommended when new equipment is being provided, as it gives the best form of protection. The average

freight shaftway, however, is more or less open, and is protected by gates of some form. The design most in favor is a counterweighted gate, which is lifted vertically by hand, and engages a supporting device when the car is at the landing. As the car moves away the gate is released and closes by gravity. "Semi-automatic" gates of this kind are preferred to automatic ones, because a gate that is purely automatic opens every time the car passes it, and this tempts employees to jump on or off the moving car as it passes the various floors. Gates should be not less than 5 feet high,—a height of 5 feet 6 inches is preferable,—and the frames should be filled in with closely spaced slats, spindles, or wire-mesh screen, to a point within four inches of the floor. Fig. 14 shows a gate of suitable form. In old shaftways, where dependence has been placed upon bar guards, lack of the necessary clearance sometimes makes it impossible to provide regulation lift gates. Fig. 16 shows how collapsible gates may be used to overcome this difficulty.

Gates of special construction are necessary in order to properly protect the shaftways of garage elevators. Failure to retain control of automobiles and bring them to a stop before they strike the gate has been the cause of quite a number of accidents, the resistance offered by an ordinary gate being of no value when the gate is rammed by a heavy touring car. Extra substantial construction is necessary in such cases. Figs. 17 and 18

show a design which has been successfully used, the actual gates here illustrated having twice prevented automobiles from falling down the shaftway. Heavy gates of this kind may be hung from tracks, or they may be supported by hinges as shown. The massive horizontal bar, which is the most essential feature, should be about twenty inches above the floor.

The shaftways of sidewalk elevators are poorly protected, as a rule, although it is highly important, for the safety of the passers-by, to effectively guard openings of all kinds in sidewalks or streets. Suitable methods of guarding or enclosing these openings are indicated in Figs. 5, 6, 7 and 8.

LIGHT: There should be plenty of light, natural or artificial, in and about freight shaftways, not only to ensure safety, but also to promote efficiency in the handling of materials. A dark shaftway is more serious in connection with freight traffic than it is with passenger traffic, because the cars themselves are not as well lighted as passenger cars.

COUNTERWEIGHT RUNWAY, CLEARANCE, OVERHEAD SUPPORTS, OVERHEAD GRATINGS, and LIMIT SWITCHES: The counsel given in connection with passenger elevators, regarding these features, applies also to freight elevators. (See pages 28 to 34.)

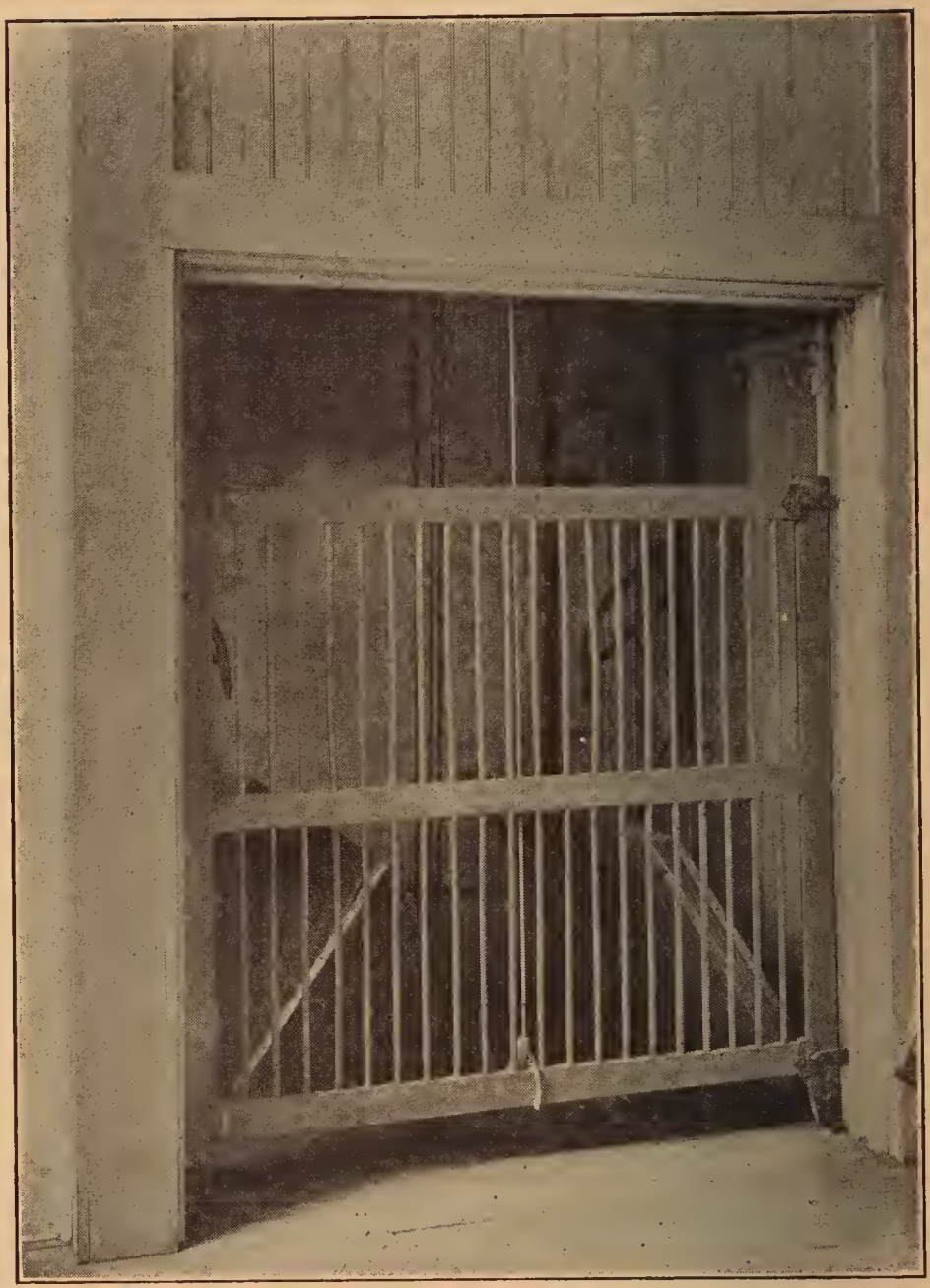

FIG. 14.—A SEMI-AUTOMATIC LIFT GATE.

(This gate, 5 feet 6 inches high, is used to guard the shaftway, and to keep persons off the folding hatch doors. A protection of this nature is desirable wherever automatic hatch doors are in use.)

FIG. 15.—A GOOD TYPE OF FREIGHT ELEVATOR SHAFTWAY GATE.

(This is covered, inside, by a sheet of canvas, which extends 15 inches above the top of the gate proper, and is supported by a light iron frame. This arrangement prevents persons from putting their heads over the gate, and it also excludes loose material from the shaftway.)

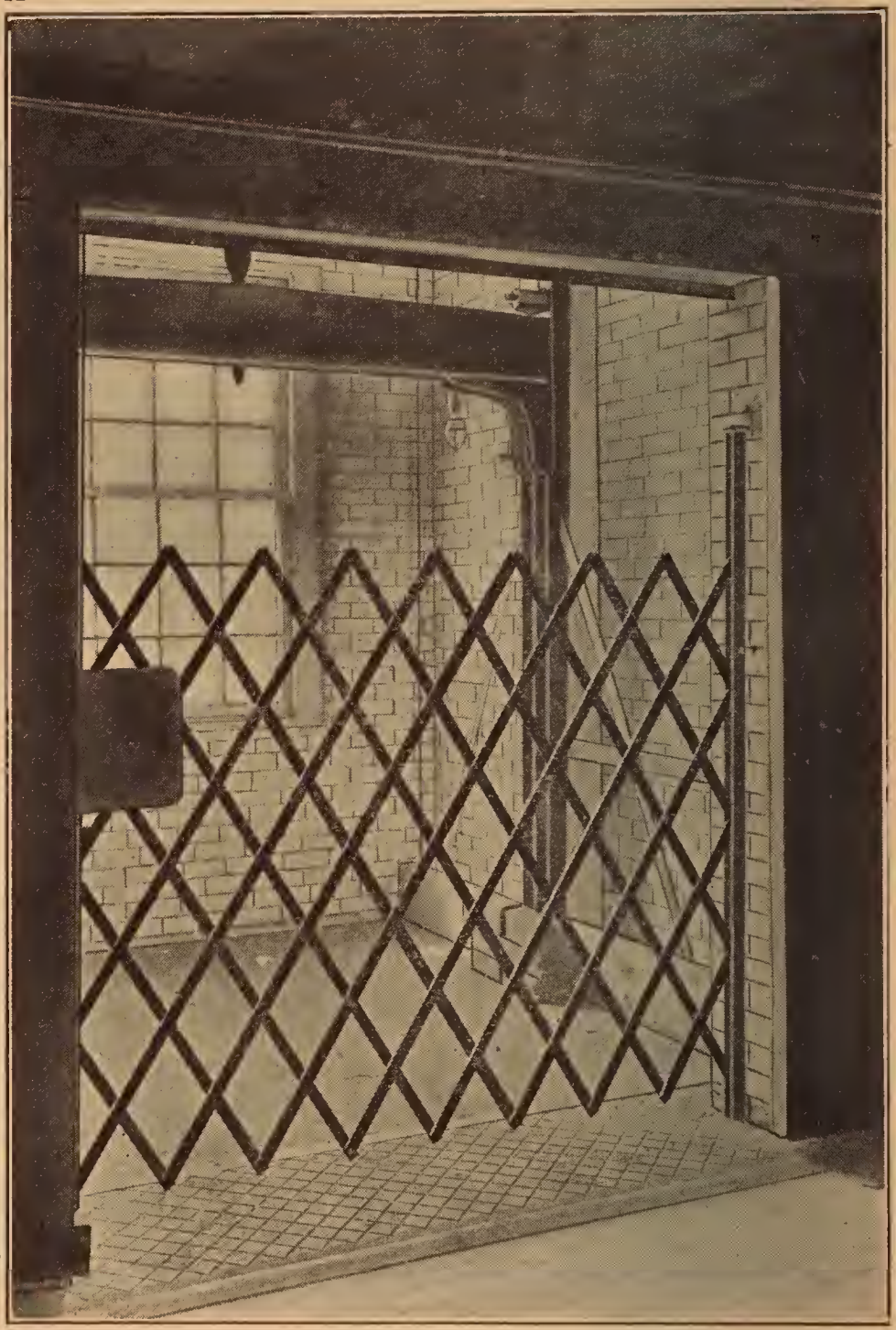

FIG. 16.—A COLLAPSIBLE GATE.

(This particular gate is installed where there is not sufficient overhead clearance for a lift gate, and fire doors prevent the use of a gate sliding along the outside wall. An overhead track supports the gate and prevents it from swinging inward, toward the car. A track may also be used for this purpose at the sill level, but it should not project above the face of the sill.)

FIG. 17.—A SHAFTWAY GATE FOR A GARAGE ELEVATOR.

(The frame is of angle iron, and it is filled in with No. 10 gauge wire-mesh. The heavy horizontal bar, which is made up of two 3-inch by 4-inch angle irons, bolted together with a core of wood between, serves as a barrier for automobiles moving toward the shaftway. Ordinary gates are almost useless on garage shaftways.)

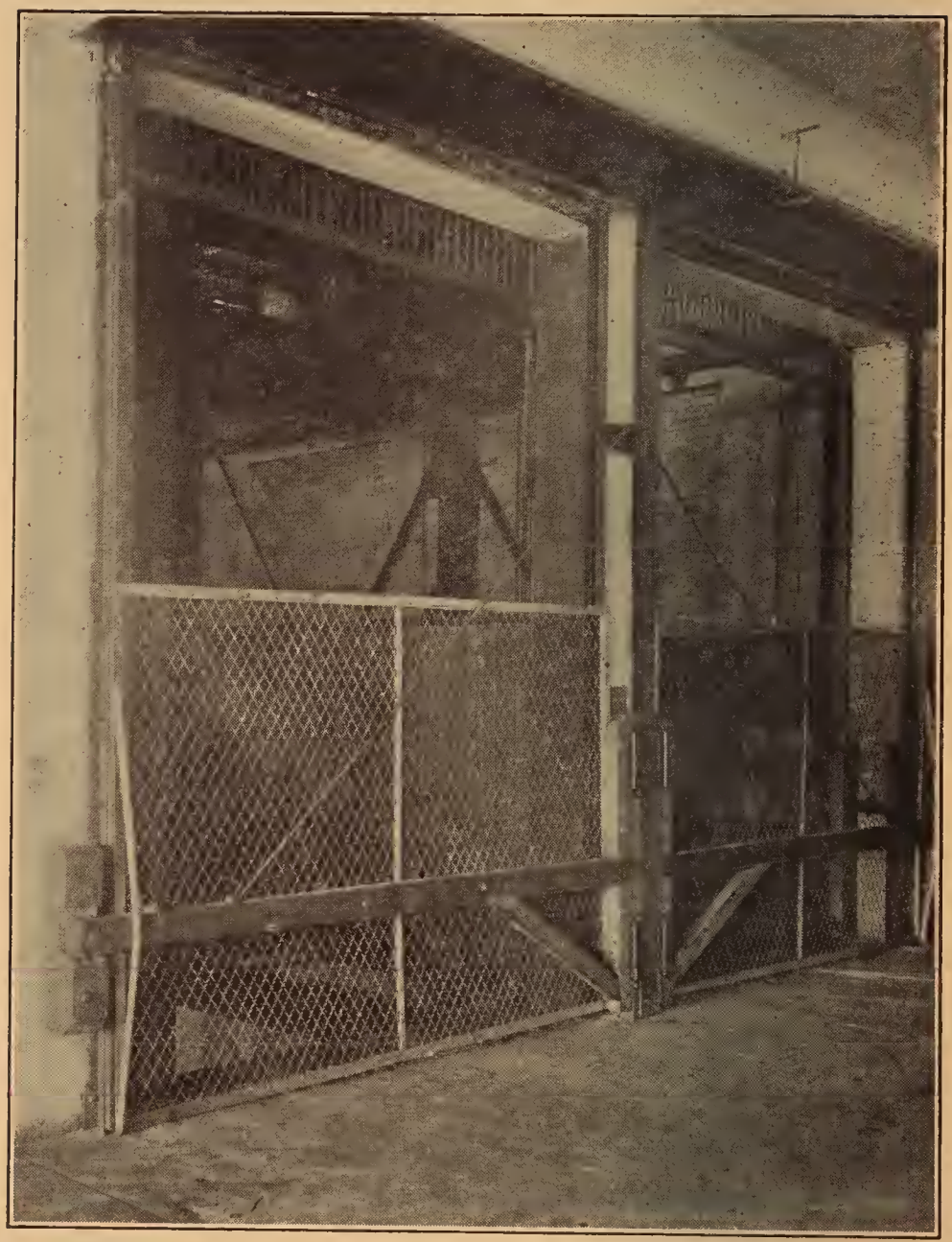

FIG. 18.—GARAGE ELEVATOR GATES AS INSTALLED FOR A DOUBLE SHAFTWAY.

(These are provided, on the inside, with locks that are accessible only to the operators. Gates of this kind can also be arranged to slide on an overhead track, where the arrangement of the walls of the building will permit.)

SIGNALS: A definite system of signalling, to indicate when and at what floor the elevator is wanted, is an exceedingly important part of every equipment. Many accidents occur through the misunderstanding of signals, or the lack of signals. The giving of signals by shaking the operating cable, rapping on a rod, or shouting in the shaftway, should be discontinued, wherever used, and suitable electrical or mechanical devices should be installed.

CABLES

For all suspended elevators, both freight and passenger, at least two cables are required in each set of hoisting, car counterweight, and drum counterweight ropes. On hydraulic and traction outfits from three to six hoisting cables are used. Except for special purposes (as for counterweights on plunger cars), the best service is secured from cables of small diameter,—say 5/8 inch, 9/16 inch, or 1/2 inch,—the number being increased, rather than the diameter, in order to provide the necessary strength. A very liberal factor of safety (certainly not less than 10) should be employed in estimating the hoisting cable requirements. Each cable in a set should be independently fastened, and special care should be taken to equalize the stresses among the several cables composing the set.

CABLE FASTENINGS

There is considerable difference of opinion as to the best form of fastening to be employed. The commonest form is the cone-shaped socket, in which the cable strands are bent back in the center and the remaining space is filled with molten babbitt or zinc. This form has been modified by separating and tinning each of the wires and leaving them spread out in the socket but not turned back, depending on adhesion of the surrounding metal to the wires to prevent them from pulling through. *When properly made* these fastenings give satisfactory service in most cases, and they are neater in appearance than other forms. They are open to some serious objections, however, since it is usually impossible to tell, by examination, whether the work has been carefully done or not. Many accidents have been recorded in which cables have pulled through such sockets, because of faulty workmanship at the time of installation, or in connection with cable renewals, which are more or less frequent. Variations in load, and the quick stops and starts to which some cars are subject, result in a twisting action on the cable, and a continual fluctuation in the tensile stresses. This occasionally results in the fracture of the wires at the point where they meet with the fusible filling of the socket; and it is almost impossible to ascertain the actual condition of the cable at this point, without melting out the filling and removing the socket.

Another form of fastening is made by bending the cable around a thimble and applying several clips to clamp the end section to the main portion. The clips should be of proper shape, and they should be made of good material, and drop forged. The clip form of fastening, although commonly used on derricks, has not been so much employed on elevators; but it has the advantage of being easily applied, and it can also be readily examined at any time. No pocket is formed in which dust or chemicals may collect and start corrosion, and the wires are not held rigid at some one definite cross-section, as they are in the "leaded socket".

Special patented fastenings may also be used with advantage for clamping the cable; but whatever form of gripping or socketing device is used, it is important that a competent mechanic be employed in applying it.

The drum connection of the hoisting or counterweight cables should be so made that two full turns, at least, will remain unwound when the car is at the extreme limit of its travel.

SHEAVES

At the present time there is little criticism to be offered in regard to the strength or the grooving of the sheaves that are being regularly installed, although in some of the older equipments they were made too light. It is common practice even at the present time, however, to provide sheaves so small in diameter that satisfactory

service cannot be had from the cables that they carry. This is particularly true in connection with freight elevators. Cables cannot be expected to wear well and resist the bending action to which they are exposed, when they are run over small sheaves. The sheave diameter necessary to secure durability depends mainly upon the cable diameter, upon the material of the cable, upon the size of the wires and the method of winding, and upon the speed. The sheave diameters listed below are the *minimum sizes* that are recommended for use in average elevator service:

Cable Diameter	Sheave Diameter	Cable Diameter	Sheave Diameter
1/4 in.	10 in.	9/16 in.	36 in.
5/16	14	5/8	42
3/8	18	3/4	50
7/16	24	7/8	58
1/2	30	1	66

Special care should be taken in mounting overhead supporting sheaves. They should preferably fit tightly on the shafts or pins, so as to obviate the use of keys and keyways, or of set screws. Variations in the size of the shaft are also to be avoided, because cracks are apt to develop where the size changes. We believe that

extreme precautions should be taken in this respect, and that no reduction in the diameter of the shaft should be allowed, even for bearings. Careless workmanship is always possible, even when proper fillets are provided; and for this reason it is desirable to eliminate shoulders entirely.

It is important to put all the sheaves in good alignment with one another, and with the fastening at the car cross-head.

COUNTERWEIGHTS

All counterweight sections should be securely bolted together; and it is important to avoid any arrangement in which loose weights with slotted ends are held only by rods which may buckle and release one or more of the sections. Headers built up of wrought steel plate with cast-iron sections between, held by four through bolts, are now being used for the better class of construction.

MACHINE ROOM

The machines that operate the elevators require a separate room in which they may be properly set and enclosed by fireproof partitions. Ample space is necessary, on all sides, to give easy access to the various parts for examination, oiling, and repairs. It is not unusual to find machines so located that proper maintenance and care is almost impossible, the engineer

being subjected to great inconvenience and danger if he attempts to clean, oil, and examine all the important devices. When located in the basement, the machine room should be wired for a sufficient number of lamps (including an extension cord and lamp) to supply plenty of light, when light is needed. The machine room should never be located underneath the shaftway, and the door to it should be kept locked, to exclude all unauthorized persons.

MACHINES

WINDING OR TRACTION-TYPE MACHINES: These machines should be direct-connected for passenger service, belt drives being adaptable only to freight machines.

On all electric machines, brakes should be designed to release electrically when power is applied, and to grip mechanically when the power is cut off or the circuit is broken in any way.

A reliable limit stop is important, to automatically cut off the power and apply the brake when the car reaches the safe limit of shaftway travel, either at the top or at the bottom. The limit stop mechanism should be constructed with solid link or gear connections, no sprocket chains being permissible.

A slack-cable device, which will shift the operating device to a stop position, or break the electric circuit, is important for all winding machines, to prevent the

hoisting cables from becoming slack under certain conditions.

Machine speed-governors are desirable for fast-running equipments, and they will no doubt become common in all electrical installations. It is hardly necessary to say that the machines should always be set on good foundations, and that they should be anchored by heavy bolts.

HYDRAULIC MACHINES: In addition to the regular operating valves, all hydraulic engines should have independent cut-off valves, to check the movement of the car at the top and bottom limits.

All valves should be suitably enclosed and protected, in an accessible location outside of the shaftway.

In both horizontal and vertical hydraulic cylinder machines it is important that heavy anchor bolts be used, and that the foundations be sufficiently massive to remain undisturbed by the stresses to which they are subjected.

All pressure tanks should be protected by one or more relief valves of sufficient size to prevent the pressure from increasing beyond the maximum allowable value, even when the pumps are working at full capacity. A factor of safety of at least five should be used in designing these tanks.

A separate discharge pipe should be provided to connect each elevator with the discharge tank.

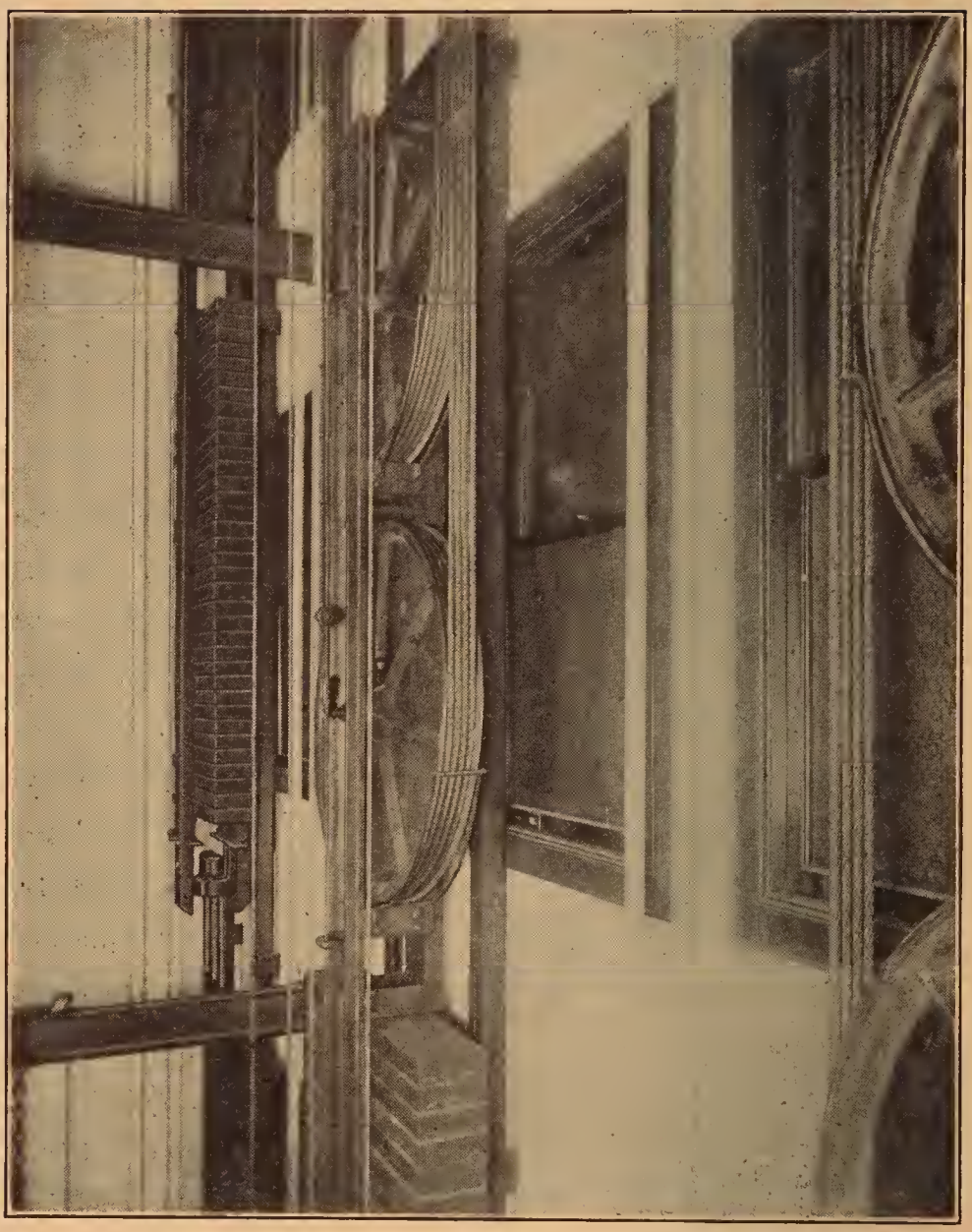

FIG. 19.—A VERTICAL HYDRAULIC EQUIPMENT, PROPERLY INSTALLED.

(Channel-iron construction is used to connect the piston rods and the traveling sheaves. Guide shoes are bolted to the channel-iron frame at the top and bottom, and these engage the steel guide rails that are provided. Guards are also installed to prevent the cables from jumping out of the grooves of the sheaves.)

On vertical cylinder machines the connection between piston rods and traveling sheaves should be made by channel iron construction instead of by forged straps, as forged straps have been found to be unreliable. Cable guards should also be provided, where necessary, to prevent the cables from leaving the sheaves in case they become slack. (See Fig. 19.)

SPEED

A speed of 300 to 350 feet per minute is adequate for the average passenger elevator, and this limit should not be exceeded. Nothing is gained by a higher speed, when carrying local passengers and making stops at all floors. When running at low speeds, stops are more easily made and the supporting parts are spared a great deal of the strain that results from bringing high-speed cars to a quick standstill at landings. For express elevators running ten or more floors without stopping, higher speeds can be used to advantage; but it is unwise to go to extremes in this direction, and we believe six hundred feet a minute should not be exceeded.

For each of the various types of elevators in common use there are innumerable important mechanical details, which are matters of good design, good workmanship, and careful installation, and which depend ultimately on the experience and methods of the manufacturer. The purchaser of elevator equipment

should consider the *reputation*, the *facilities*, and the *experience* of the builder, as well as the specifications that are submitted. He should understand that the construction of modern passenger elevators is a highly specialized line of work, which can be satisfactorily handled only by a well equipped manufacturer, making a specialty of building this class of machinery. The same is true of freight elevators also.

OPERATION

The operation of any elevator is a man's job, and a man should be provided for that purpose. The safety of the equipment depends in large measure upon the method of handling, and boys or women should never be assigned to this work, nor be permitted to undertake it. Mature judgment is necessary not only in times of emergency, when something goes wrong, but also in preserving good order on the car and at the shaftway entrances, and in preventing crowding or overloading. A certain amount of experience is essential to the proper control of an elevator, and an inexperienced operator should never be placed in charge. For high speed service considerable time is required to develop a good operator, even after experience has been acquired in the handling of moderate speed cars, and some men *never* become proficient or reliable at this kind of work. Far less skill is required in running freight elevators, but it is nevertheless highly important to instruct new

freight operators carefully, and to keep them for some time under the direction of reliable and experienced men.

Aside from the question of safety, it is false economy to provide young, inexperienced operators in public buildings. The modern building manager considers his elevator men of great importance in the successful performance of the daily routine, and he endeavors not only to get good men, but also to keep them, and to make as few changes as possible. He realizes that these men are of value not only in their skillful manipulation of the controlling devices and in the safe handling of the traffic, but also in their acquaintance with tenants, in knowing the location of the various offices, in leaving tenants at the right floors, and in gaining good will and confidence in other ways.

It is now commonly and almost universally admitted that passenger elevators should be run only by regular operators. The same principle applies to freight elevators also, though the extension of the idea to them may seem extreme to those who are accustomed to the rather familiar practice of leaving the freight car to be operated by anybody who has occasion to use it. The dangers involved in this practice, and the large number of fatal or otherwise serious accidents that result from it, are sufficient to convince anyone that a regular operator is quite essential to safety. Where the elevator is not kept very busy, the operator can sometimes do the loading and unloading with advantage.

In other cases, where the freight service is light, some particular employee who has had the needful instruction and experience should be assigned to answer calls for the elevator, and to run it when it is needed.

STARTERS: In office buildings and stores, where several elevators are operated side by side, it becomes important to provide reliable starters to have charge of the operators, to see that a suitable schedule is maintained, and to prevent confusion or the overloading of cars. Men of good presence and considerable experience should be selected for this work.

One starter, located at the main floor, is ordinarily sufficient, but in large department stores it is advisable to have two starters on the main floor and one on each of the upper floors, in order to insure proper control of crowds, and to look after the safety of the women and children who make up the principal part of the traffic.

CARE AND MAINTENANCE: A competent engineer to take care of the mechanical equipment is one of the most vital requirements for the safety of all concerned in elevator service, and one which receives far too little consideration, especially where but one or two cars are operated. The practice of leaving such important apparatus to the care of inexperienced men, who have no mechanical ability and no knowledge of elevator mechanism, cannot be too strongly condemned. A false impression seems to have gained a foothold,

especially among owners and lessees of buildings where but one or two elevators are used, that the only attention required is the liberal use of oil and grease,—some "handy man", clerk, or young operator being detailed to apply the lubricant. Cables become rusted; bolts get loose and drop out; safety devices become ineffective through corrosion, lack of adjustment, or the accumulation of gummed oils and dirt; motor commutators, controlling switches, and wiring are neglected; valves and pistons are not kept properly packed; shaftway doors and locks become defective; overhead bearings run dry; and many other important features are overlooked. It is not always practicable to have an engineer in constant attendance at small plants, but arrangements should be made by which such a man will call daily, see that all vital parts are in good working order, and make any repairs or adjustments that may be necessary.

INSPECTION: Systematic inspections at regular intervals have long been recognized as essential to safe operation. An inspection service of the highest order is furnished by THE TRAVELERS to its policyholders, free of charge; and this service is valuable not only in connection with accident prevention, but also in promoting economy of operation.

INSTRUCTING THE PUBLIC: The elevator-using public is responsible for a considerable proportion

of the elevator accidents that arise from carelessness, absent-mindedness, and ignorance of the dangers that are involved in the disregard of the reasonable regulations that experience has suggested. Messenger boys delight in running along hallways, and sliding or diving for open shaftway doors that are about to be closed, or opening doors that are not securely locked; and business men and women do not hesitate to violate, in a more decorous way, various important rules that are quite essential to safety.

Regulations should be posted, whenever and wherever needful, for the instruction and warning of the tenants and the general public; and these regulations should be strictly enforced. It will be easiest to enforce them in office buildings, where starters are employed; but they should also be carried out elsewhere, so far as their execution may be possible or practicable.

CONTENTS

NOTES

The Travelers In

HARTFORD, CONNECTICUT

Makes a specialty of elevator inspection and engineering, and gives its patrons the benefit of years of study and experience.

☛ Its Inspections are the Best

¶ They are made at regular intervals, and very thoroughly.

¶ They are made by men who are specially trained in this line of work.

¶ They are of the same NEW STANDARD type that has made The Travelers famous in all its engineering lines.

STEAM BOILER INSURANCE

is issued by

The Travelers Indemnity Company

HARTFORD, CONNECTICUT